Documentation Author

Frederic Lambercy for K-Team S.A.
Rue Galilee 9
1400 Yverdon-les-Bains
Switzerland

email: info@k-team.com
Url: www.k-team.com

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Table Of Contents

1 Introduction

The KoreMotor controler board can be used as a KoreBot extension or as a standalone module that is able to control four DC motors. It provides an open loop interface or PID algorithm control with several complementary features such as current limitation, software position limits and internal commands generator.

The KoreMotor can receive commands from a serial RS232 link, an I2C bus or a KNet connection from a Koala or a KoreBot.

2.1 Overview

The KoreMotor hardware provides four motor controllers, each one including a H-Bridge, microcontroler and motor connector. The fifth microcontroler manage the board communications, dispatching orders to the controllers, it is refered as the translator. Different settings and connections are required depending on the KoreMotor usage. Dip switches control the board running modes and the communication interface will set the required connections. Figures 2.1 and 2.2 describe the board main components.

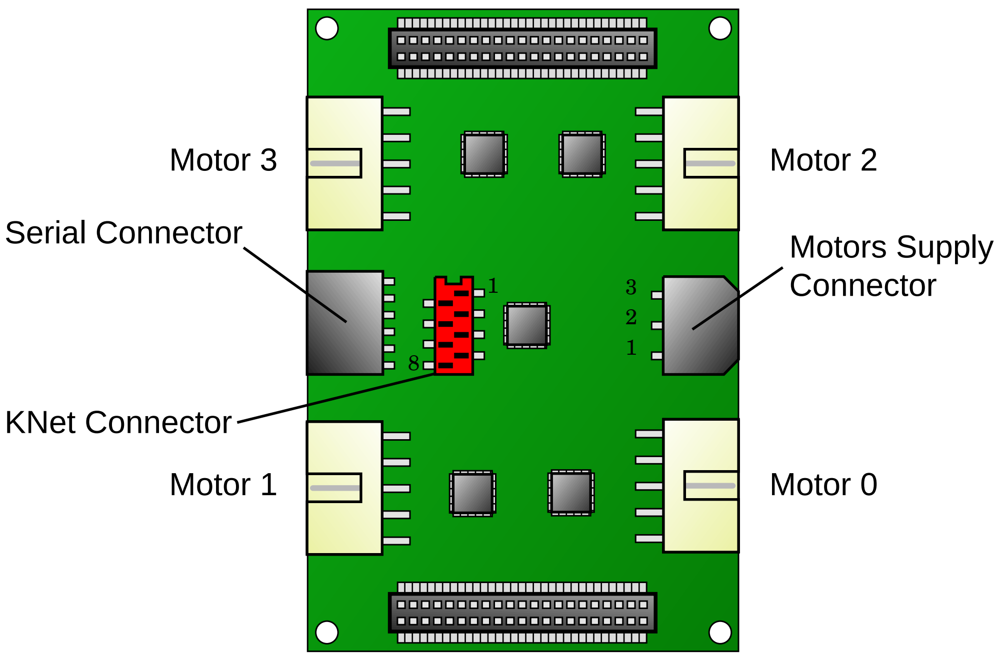


Figure 2.1: KoreMotor hardware overview

2.1.1 Dip Switch Settings

The running mode for the KoreMotor is set with the dip swicth position at startup. The settings are described on figure 2.2. If the switch position is modified at run time, the mode will not change until the next reset.

I2C Standalone : That mode is used to control the board from an I2C bus. The I2C bus is directly connected to the motor controllers, and the I2C addresses for each controller are detailled in section 2.1.2. The translator is not used in this mode. The KoreMotor can be connecter to any I2C master as a standalone I2C device, for instance a KoreBot can be configured as an I2C master for the KoreMotor.

Koala KNet : The Koala KNet mode is the classical KNet protocol implemented on the Koala robot and the Khepera robot. This mode is mainly designed to connect a KoreMotor as a Koala extension, refer to the Koala user manual for details about the KNet protocol.

RS232 User Interface (115200): User serial commands (see section 4.1) can be send to the KoreMotor serial interface with this mode. The serial line settings should be 115200 bps, no parity, 8 data bits and 2 stop bits.

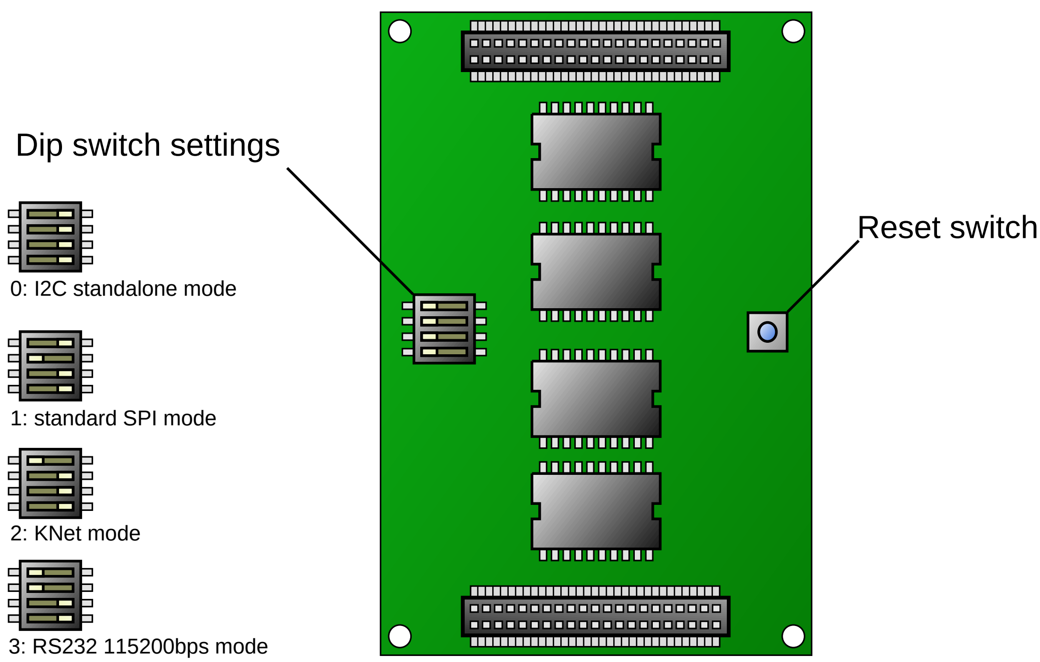


Figure 2.2: Dip switch settings

2.1.2 Controllers I2C Addresses

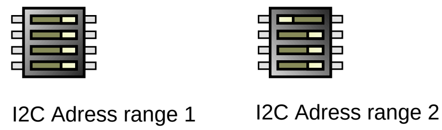
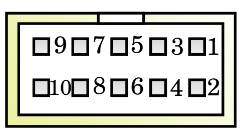


Figure 2.3: KoreMotor I2C address range

The last dip switch, as displayed on figure 2.3 is used to choose the I2C address range for the motor controllers. The address range is usefull to stack two KoreMotor together, using the same I2C bus.

	Range 1	Range 2
Motor 0 address	0x01	0x05
Motor 1 address	0x02	0x06
Motor 2 address	0x03	0x07
Motor 3 address	0x04	0x08

2.1.3 Motor Connection Pinout



1. Motor +	6. Motor –
2. Encoder 5V	7. Motor +
3. Encoder Canal A	8. Motor –
4. Encoder Canal B	9. Encoder Index
5. Encoder Gnd	10. Encoder Index

Figure 2.4: KoreMotor connector pinout

The KoreMotor provides four DC motor connectors. The motor connection may vary from a manufacturer to another, but the signals for quatrature encoders are usually similar. Please refer to your motors manufacturer datasheet for details about the motor connections, contact support@k-team.com if further help is necessary.

Motor+ : First motor connection

Motor- : Second motor connection

Encoder 5V : Power supply for the encoder

Encoder Gnd : Ground reference for the encoder

Encoder A : First encoder phase

Encoder B : Second encoder phase

Encoder Index : Index for the encoder. This signal is not available for all encoders and it is not required.

2.2 KoreMotor Connections

The KoreMotor requires a power supply connection and an external interface connection. The main power supply is the motors supply, it should be set according to the motors requirements, regarding voltage and necessary current, and is common for all motors. Another supply may be necessary for the electonics on the board. This supply is provided from the KoreBot or the Koala when the KoreMotor is used as an extension, but it is required for standalone use.

The external interface depends on the chosen dip switch settings. The possibilities are:

- KoreBot connection for I2C or KNet 2.0 interface
- Koala connection for KNet interface
- Standalone serial connection for both RS232 interface
- Custom connection for a standalone I2C interface

2.2.1 Standalone Serial Connection

The standalone serial connection is used for both serial protocol mode. A KoreConnect option, which provides the RS232 transceiver, is necessary to use the KoreMotor in standalone serial mode. A custom made RS232 transceiver can be used as well, schematics are available on request at support@k-team.com. The serial cable can then be connected to any PC. A 5V supply voltage is required for the board electronic components (see section 2.2.1).

How to Supply 5V for Electronics

When using the board as a standalone module, a 5V external supply is necessary. That supply should be provided using the red KNet connector (see section 2.1) as displayed on figure 2.6.

2.2.2 KoreBot Connections

The KoreBot connection is pretty straightforward, the boards should be simply stacked together. The KoreBot will provide the electonics 5V supply, and only the motors supply should be added.

Dip switch setting should be standalone I2C to use the I2C bus for communications between the KoreBot and the KoreMotor.

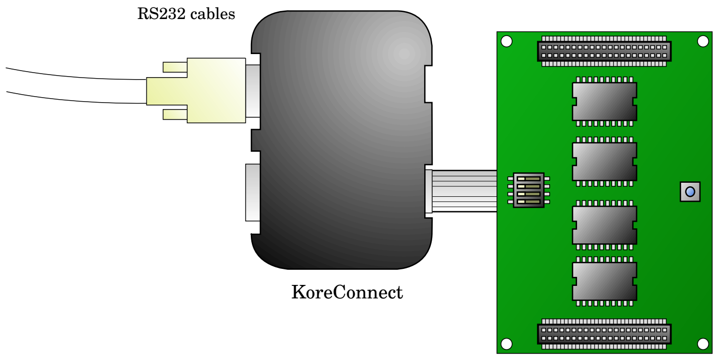


Figure 2.5: Standalone serial connection

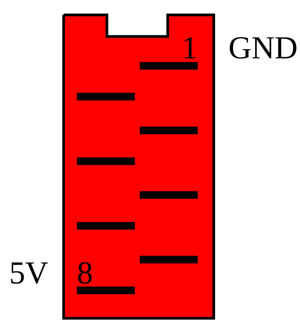


Figure 2.6: Standalone 5V electronics supply

2.2.3 Koala Connections

The Koala must be connected to the KoreMotor using the red KNet connector (see section 2.1). A cable should be provided with the KoreMotor to be connected with the Koala K-Bus connector (please refer to the Koala user manual for more details).

The electronics supply is provided from the Koala, the motors supply can be connected to an external source or to the Koala 12V outputs.

Dip switches should be set to the Classical KNet mode, the Koala does not support the KNet 2.0 protocol.

2.2.4 Standalone I2C Connections

1. I2C SDA	4. Serial Tx
2. I2C SCL	11. Gnd
3. Serial Rx	12. Gnd

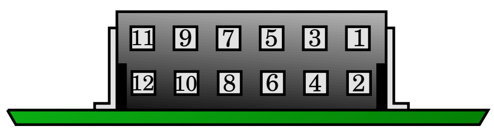


Figure 2.7: KoreMotor serial connector and I2C connections

The KoreMotor can be connected to an external I2C bus, and controlled as a set of standard I2C devices (see section 2.1.1 for details). Three signals (SDA, SCL and GND) are necessary to connect the I2C bus, they are displayed on figure 2.7 with the relevant connections on the serial connector.

The electronics supply must be provided separately, and the dip switches should be set to standalone I2C mode.

2.2.5 Motors Supply Connector

The main power connector will supply all the motors, the voltage should match the motor requirements, and stay within the accepted voltage range for the H-Bridges. The connector pinout is detailed on figure 2.8.

Voltage range	5-28V
Max global current	5A
Max current per motor	2A

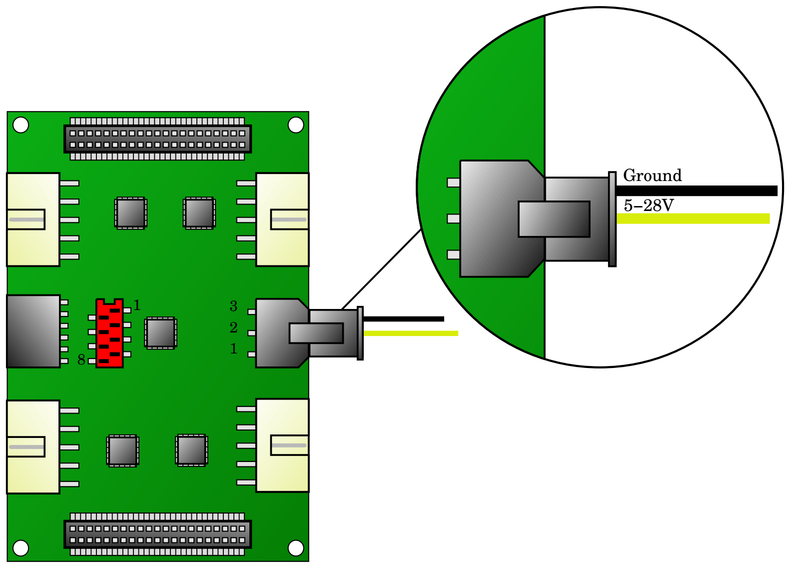


Figure 2.8: Motors power connection

2.3 Hardware Protection

2.3.1 Electrostatic Discharge Protection

As any electronic device, the KoreMotor can be damaged by Electrostatic Discharge. The quadature encoders interface chip on the board has been identified as very sensitive and special care should be taken to avoid any problem. It is recommended to connect the KoreMotor ground signal to the earth or with the robot chassis for embedded use.

A quadrature encoder interface failure will shut the board ability to read encoder feedback and globaly prevent the related motor controller proper operation.

2.3.2 Motor Controller Fuses

The motor cotrollers are protected from overcurrent with dedicated fuses. Each motor channel is protected with a 2 Amps fuse, and the board is protected with a general 5 Amps fuse. Higher peak currents are normaly supported by the board and all its components, but continuous operations should respect these limits.

Please contact your K-Team dealer for support if a fuse replacement is required.

3.1 Controler State or Mode

Each motor controller status is indicated, or can be modified, using the mode register (0x28). This register should be read to check the controller state, and it can be written to switch from a mode to another. The following modes are available:

Idle mode: This is the default startup state (except if hardware option 0 is set). While in idle mode the controller will not execute any regulation and the motor is free wheeling.

Control mode: The controller must be switched to this mode for any regulation to start. When exiting Control Mode, the regulation will stop according to the new mode description.

Stop mode: When switched to this mode, the controller will hold the motor in blocked state (both motor pins are electricaly connected).

Sleep mode: The controller is switched to a minimal activity status and the motors are set to free wheeling. This mode can be used to optimize power consumption.

Reset mode: Mode to reset the controller. The controller will then switch to the startup mode, according to hardware option 0.

Save configuration mode: Save all registers to EEPROM for backup. A special protection patern must be written in register 0x28 to access this mode. Values 0x55, 0xAA and 0x05 must be written sequentially to enter mode 5. The first two values are not stored to the register and cannot be read. The controller will switch back to idle mode when the backup is completed.

Search limit mode: This mode will start a mechanical limit detection routine. The routine will use speed regulation to perform the test, using the current target point setting and motor blocked test (see section 3.8). Resulting 32bit positions are stored in SoftStopMin (0x4A-0x4D) and SoftStopMax (0x4E-0x51). The controller will switch back to idle mode when the test is completed.

3.2 Controller Status Registers

Two registers detail the motor controller status. Bit will be set by the controller in the Error register (0x2D) to signal problems. Generic information about the controller are given in the Status register (0x2E).

Some errors, from error 0 to 4, are blocking errors, that means the controller will stop until the error are not cleared. The error will be cleared only if the error condition has been resolved and after the Error register is cleared from the application, that means writing 0x0 to the error register. If a blocking error is triggered because of a physical condition, such as a blocked motor, the condition itself should be resolved before clearing the error register.

Error register

bit0 :	Sample time too small	The defined sample time is too small for a complete calculation cycle.
bit1 :	Watchdog timer overflow	Refer to the PIC16F876 datasheet
bit2 :	Brown-out	Refer to the PIC16F876 datasheet
bit3 :	Software stoped motor	The motor position is off-limits and the sw_stop_error option is enabled.
bit4 :	Motor blocked	The motor blocked condition is met (see section 3.8) and the sw_blocked_stop option is enabled.
bit5 :	Position out of range	Not implemented
bit6 :	Speed out of range	Not implemented
bit7 :	Torque out of range	Not implemented

Status register

bit0 :	Movement detected	Motor speed is not null
bit1 :	Direction	Movement direction 0=negative 1=positive
bit2 :	On setpoint	The regulated value match the Set-Point value
bit3 :	Near setpoint	The regulated value is inside the target zone
bit4 :	Command saturated	The PWM ratio has reached 100%
bit5 :	Antireset windup active	Set if the command is saturated and if sw_windup is enabled
bit6 :	Current control active	
bit7 :	Softstop active	The position is off-limits and the corresponding option is enabled (section 3.2.2)

3.2.1 Target Zone

The near setpoint flag is set whenever the regulated value is such as:

$$|SetPoint - RegulatedValue| \leq NearTargetMargin$$

That means the NearTargetMargin register defines a zone around the target point. which can be useful for specific applications.

3.2.2 SoftStop Limits

The Controller can be configured to setup virtual position limits for movements. This feature is very useful to protect mechanical devices powered by the KoreMotor. As soon as the position is under SoftStopMin (0x4A-0x4D) or over SoftStopMax (0x4E-0x51), the controller will shutdown the motor driver to prevent any further movement regardless of the target setpoint and controller mode.

The SoftStopMax limit is only active if the sw_stopmax option is enabled and the SoftStopMin limit is only active if the sw_stopmin option is enabled. Any combination of these two options is valid, and they should be set according to each specific application requirements.

3.3 Controller Option Registers

The controller behaviour can be configured using the two option registers (0x2A and 0x2B) where each bit will enable or disable a feature. The registers can be read at any time to retrieve the current option settings and options are activated or disabled as soon as a register is written.

Software option register

bit0 :	sw_separated	Use alternate algorithm PID derivation. The derivate part is calculated using the process variable rather than the error.
bit1 :	sw_windup	Activate the anti reset windup routine.
bit2 :	sw_stopmin	Stop the motor if the min position is reached (section 3.2.2).
bit3 :	sw_stopmax	Stop the motor if the max position is reached (section 3.2.2).
bit4 :	sw_stop_error	Generate an error when position is out of limits, in this case the error must be reseted before any further commands can be executed.
bit5 :	sw_blocked_stop	Stop the motor if the blocked condition is met (section 3.8).
bit6 :	sw_current_ctrl	Activate software current limitation (Not implemented)
bit7 :	sw_dir_inv	Invert the motor direction.

Hardware option register

bit0 :	hw_startup	Startup mode (0 = idle mode, 1 = control mode)
bit1 :	hw_analog_set	Use analog input for setpoint (Not Implemented)
bit2 :	hw_led	Not Implemented
bit3 :	hw_resolution	Resolution for the encoder (0 = 100%, 1 = 25%)
bit4 :	hw_torque_inv	Invert the internal current measurement
bit5 :	hw_opt1	Not Implemented
bit6 :	hw_opt2	Not Implemented
bit7 :	hw_opt3	Not Implemented

3.4 Measurements

Each controller can return the motor incremental position, the motor current speed, and the current through the motor. Each measurement can be retrieved reading the corresponding registers, the most significant bits for each value should always be read first to ensure data consistency.

3.4.1 Position

The returned motor position is an accumulated counter of encoder pulses. The physical position can be calculated knowing a reference position and the

pulse per turn value for the encoder. The position registers can be writen to set the current position to a given value at any time.

3.4.2 Speed

The speed value is a division of a constant value by the time between encoder pulsations. In default mode (pulsation x2 and postcaler 1:4), a measure is made every two pulsations. The constant value is define by the maximum time multiplied by 256 (0xFFFF * 256 = 16'776'960). This operation allows a better pid calculation for the lower speed.

$$MotorSpeed = \frac{16'776'960}{Timer5value}$$

To convert into a real time, use the following calculation:

$$Time = \frac{Timer5value}{\frac{f_{osc}/4}{Tmr5Prescaler}}$$

Where f_{osc} = 20MHz and Tmr5Prescaler = 8 (default).

3.4.3 Current

The measured current (Torque registers) is proportional with the maximum supported current. The default maximum current is 2 Amps, and it is represented by a +512 measured current. A −512 value represents the reverse maximum current (thus 2 Amps by default), any intermediate value can be deduced from the proportional relation. The maximum supported current can be reduced to increase the current measurement resolution, please contact K-Team for further information.

The current measurement can be disturbed because of the analog amplifier bias. That means a null value for the measured current does not match the motor standby current. The Torque bias register (0x3C) is used to correct this variation, the default bias is measured at startup, when it is assumed the motor is not moving. The returned current value is corrected using the bias such as:

$$RetunedValue = MeasuredValue - Bias$$

The default bias can be modified if the startup value is incorrect.

3.5 Regulation Type

The controler supports six different type of regulation. Each regulation will use a specific set of PID coefficient, depending on the parameter which is actually regulated. The PID coefficients are usual proportional, derivate

and integral gains for the controller, several other settings may be required for each specific mode and application.

The 32 bit SetPoint value (0x2F-0x32) is always used as the controller input. According to the regulation type, this register will set the target position, speed, or current. The actual controller internal input is only updated when the least significant byte is written (0x2F) to ensure consistency.

Open Loop control: The open loop mode does not use the PID controller. The SetPoint value will directly set the output PWM ratio. The PWM timer for the controller is a 10 bit timer, that means the PWM ratio can vary from $+1024$ to -1024 with the sign indicating the direction. A null value generates no signal, while a 1024 value generate a 100% PWM ratio (continuous signal).

Position control: The motor position is regulated to the SetPoint value. The position coefficients are required for the PID controller.

Position control with speed profile: A speed profile is used to reach the target position defined in the SetPoint registers. The speed regulation is actually used to follow the speed profile that is why speed coefficients are required for the PID controller. The position PID is not used in this mode. The speed profile is defined by the MaxSpeed register (0x6D) and Acceleration register (0x52), see section 3.6 for further details. The final position is held using the blocked motor mode in the target zone, which is defined using NearTargetMargin (0x60).

Speed control: The motor speed is regulated to the Setpoint value. As speed is a 16 bit measurement, no speed beyond $\pm 2^{15}$ can be regulated. The speed coefficients are required for the PID controller.

Speed control with acceleration profile: The motor speed is regulated to the SetPoint value, but an acceleration ramp is used to reach the final speed. According to the Acceleration register (0x52) and current speed, the speed is gradually increased or deacreased until on SetPoint.

Current Control: The motor current is regulated to the SetPoint value. As current is a 10 bit measurement, no current beyond $\pm 2^9$ can be regulated. The current coefficients are required for the PID controller.

3.6 Controller Speed Profile

When using position control with speed profile mode, the controller aim for a *target position* using a *speed control* PID. That means the position itself is not regulated, even thought the given SetPoint is a position. On the other hand, the motor speed is regulated according to the built-in speed

profile. Figure 3.1 describe the speed profile, as it can be configured using the MaxSpeed and Acceleration registers.

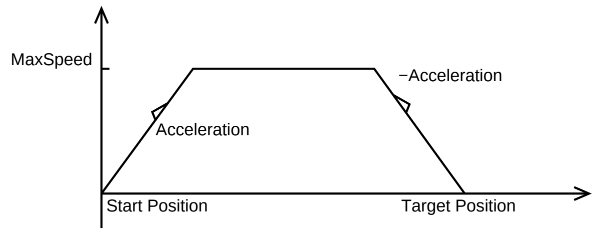


Figure 3.1: Speed Profile

3.7 SetPoint Sources

The target point (see section 3.5) for the controller can be set from various sources. The most common use is to set the target point by writting into the SetPoint registers (0x2F-0x32) but other sources may be useful for specific applications.

The source can be modified using the SetPoint Source register (0x29). The default mode 0 requires writting to the SetPoint register, other modes will use internal generators as described bellow.

Square Generator: As displayed on figure 3.2, the mode 2 will generate a square wave signal for the SetPoint according to the IntGenPeriod, IntGenAmplitude and IntGenOffset registers. IntGenOffset is a signed value.

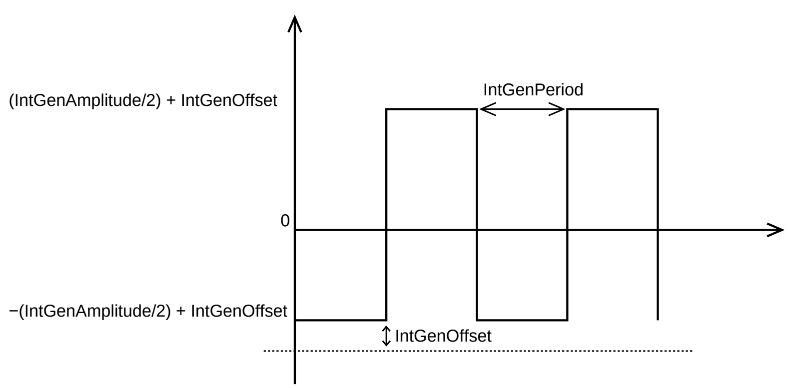


Figure 3.2: Square waveform

Triangle Generator: As displayed on figure 3.3, the mode 3 will generate a triangle signal for the SetPoint according to the IntGenPeriod, IntGenAmplitude and IntGenOffset registers. IntGenOffset is a signed value.

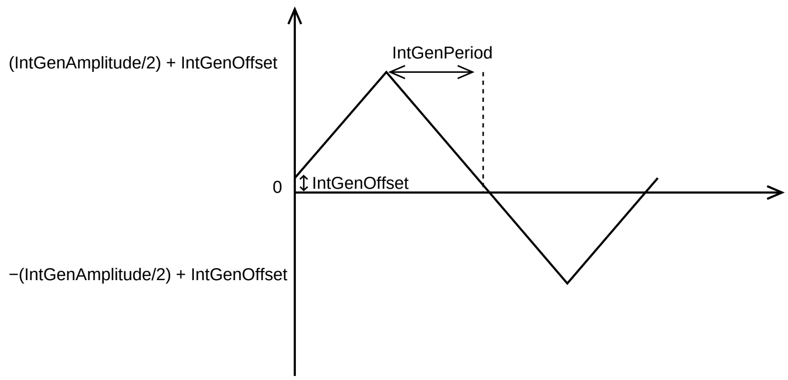


Figure 3.3: Triangle waveform

3.8 Motor Blocked Test

The controller uses a built-in routine, based on movement and current measurement, to detect if the motor abnormaly blocked. A blocked condition is met only if the motor is not moving and if the measured current is over the defined SWCurrentLimit (0x56-0x57). The motor blocked flag and eventual error are only triggered if the both conditions are met during at least a BlockedTime (0x46) period.

That means the blocked flag will never be set if the motor is moving, even very slowly, and it will never be set if the current limit is not defined properly, according to the controlled system.

The blocked time period can be calculated from the sampling period such as:

$$BlockedPeriod = 2 * SamplingPeriod * BlockedTime$$

3.8.1 Mechanical Limit Detection

Controller mode 6 can be configured to use the built-in mechanical limit detection routine. The mechanical limit detection is based on the motor blocked test, that should be configured properly before switching to this mode. The routine will use the current SetPoint value as the target speed to perform the test, that is why the SetPoint register should be adjusted as well.

Once all relevant registers are set, switching to mode 6 will start the detection routine. The routine will search for mechanical limits in both directions. If no limit is reached in one direction or another, the test will fail and the routine will run continuously, driving the motor at the given SetPoint speed, until the controller mode is manually changed.

Resulting 32bits positions for mechanical limits are stored in SoftStopMin (0x4A-0x4D) and SoftStopMax (0x4E-0x51). The controller will switch back to idle mode when the test is completed.

3.9 Sampling Period

The controller sampling period is the time between two output calculations. That means the PWM ratio to control the motor is only updated once every sampling period.

A shorter sampling period may result in a more accurate control but requires a better encoder resolution. If the encoder resolution is too bad, the controller might not count any pulse during a sampling period thus assuming no movement, even if the motor is rotating. Moreover, if the sampling period is too small, error 0 may occur, indicating that the microcontoller is too slow to complete all the PID calculations in a single period.

On the other hand, if the sampling period is too long, the controller might not be quick enough to regulate the system, as its reaction time might become too long.

Setting a correct sampling period is critical to ensure proper motor control.

The Sampling period should be set using the SampleTimeH register (0x45). The internal timer provide a $1.6\mu s$ resolution for the sampling time so that the sampling period can be calculated as:

$$SamplingPeriod = (SampleTimeH * 256) * 1.6\mu s$$

The SampleTimeL register (0x44) can be used for finer tuning of the Sampling period, down to a $1.6\mu s$ resolution, but period under $1300\mu s$ are very unlikely to be acceptable.

4 Serial Communication Protocol

4.1 Generic User Syntax

The KoreMotor supports various high level serial commands to control the board from a host Personnal Computer. The serial command syntax is similar to the Khepera syntax with some enhancements.

Each command is a letter eventually followed by numerical arguments. Arguments format is either 8bit (default), 8bit hexadecimal, or 32bit integer. The format for each argument is given in the command description (ie value.format), but is 8bit by default. A prefix must be added to an argument with a specific format as described in the following table:

32bit integer	l
16bit integer	d
8bit hexadecimal	0x

Some user command syntax examples:

```
Set options:  O,0,0x24,0x02

Set target point:  P,0,1,l-100

Set Position:  A,1,l20

Configure PID:  C,2,1,d300,d0,d120
```

4.1.1 User Syntax Configuration Example

Configuration of a motor controller (number *mot*) from the serial line.

```
W,mot,0x28,0           -  Set mode
W,mot,0x33,0           -  Set filter order
W,mot,0x45,6           -  Set sample time
W,mot,0x60,10          -  Set error margin
W,mot,0x2D,0           -  Reset all error flags
W,mot,0x46,10          -  Set default blocked time
L,mot,5,l50,l0         -  Set current limit
L,mot,1,l-10000,l10000 -  Set position limit
O,mot,0,62             -  Set options
C,mot,3,d1500,d0,d300  - Configure speed PID
C,mot,1,d70,d50,d10    - Configure position PID
J,mot,d10,1            - Set speed profile
S,mot                  - Save Config
```

```
N,mot,2,l3              - Search for limits
R,mot,0x4A             - Read min position byte 0
R,mot,0x4B             - Read min position byte 1
R,mot,0x4C             - Read min position byte 2
R,mot,0x4D             - Read min position byte 3
R,mot,0x4E             - Read max position byte 0
R,mot,0x4F             - Read max position byte 1
R,mot,0x50             - Read max position byte 2
R,mot,0x51             - Read max position byte 3
```

4.2 Regulation Type

The motor controller supports five different type of regulation (see section 3.5), serial commands set the affected regulation using a number, according to the following table. A command requiring a regulation type must use one of these reference number.

0:	Open loop control
1:	Position PID control
2:	Position control with a trapezoidal speed profile
3:	Speed PID control
4:	Speed with trapezoidal accelaration profile

A Register Summary

Name	Address	Description
Mode	0x28	Selection of mode (0..7) 0 = Idle Mode 1 = Normal Control Mode 2 = Stop Motor 3 = Sleep Mode 4 = Reset Mode 5 = Save configuration parameters (page 0) in E2PROM 6 = Search Limit Mode 7 = Unused
SetPointSource	0x29	Source of SetPoint (0..7) 0 = External I2C 1 = External Analogic (not implemented) 2 = Internal Square Wave Generator 3 = Internal Triangle Generator 4 = Internal Sinus Generator (not implemented) 5 = Not used 6 = Not used 7 = Not used
HW_Options	0x2A	Hardware options (Flags) Bit0: Define Startup Mode, 0=Idle Mode / 1=Normal Control Mode Bit1: Analog SetPoint Input, 0=disabled / 1=enabled Bit2: LED, 0=disabled / 1=enabled Bit3: Encoder resolution, 0=100% / 1=25% Bit4: Torque Inversion Bit5: Driver Option 1 Bit6: Driver Option 2 Bit7: Driver Option 3
SW_Options	0x2B	Software options (Flags) Bit0: Seperate D, 0=disabled / 1=enabled Bit1: Antireset Windup, 0=disabled / 1=enabled Bit2: SoftStop MIN, 0=disabled / 1=enabled Bit3: SoftStop MAX, 0=disabled / 1=enabled Bit4: Error on SoftStop, 0=disabled / 1=enabled Bit5: Stop Motor when blocked, 0=disabled / 1=enabled Bit6: Current Control by Software, 0=disabled / 1=enabled Bit7: Direction invertion, 0=disabled / 1=enabled

ControlTyp	0x2C	Type of PID Control (0..7) 0 = Open Loop 1 = Position control with no speed Profile 2 = Position control with Trapezoal Speed Profile 3 = Speed control with no speed profile 4 = Speed control with Trapezoal acceleration Profile 5 = Torque control 6 = Zero Friction control (not implemented) 7 = Not implemented
ErrorFlags	0x2D	Flags indicating an error (read only!) Bit0: Sample time to small Bit1: Watchdog timer overflow Bit2: Brown-out Bit3: SoftStop happened (only if SoftStop enabled) Bit4: Motor blocked (only if Motor stop while blocked enabled) Bit5: Position out of range (Overflow), 0=No / 1=Yes Bit6: Speed out of range (Overflow), 0=No / 1=Yes Bit7: Torque out of range (Overflow), 0=No / 1=Yes
StatusFlags	0x2E	Flags indicating the status of the controller (read only!) Bit0: Movement detected, 0=No / 1=Yes Bit1: Direction of movement, 0=negative / 1=positive Bit2: On SetPoint, 0=No / 1=Yes Bit3: Near SetPoint (+/-5units), 0=No / 1=Yes Bit4: Saturation of Driver Command, 0=No / 1=Yes Bit5: Antireset Windup active / Integrator Owerflow, 0=No / 1=Yes Bit6: Current Control active, 0=No / 1=Yes Bit7: SoftStop active, 0=No / 1=Yes
SetPointLL SetPointLH SetPointHL SetPointHH	0x2F 0x30 0x31 0x32	32bit target point Target point is only updated when the LL value is writen
PositionLL PositionLH PositionHL PositionHH	0x34 0x35 0x36 0x37	Always first read the PositionHH register!!! These 4 variables contain a copy of the 32bit position
SpeedLL SpeedLH SpeedHL SpeedHH	0x38 0x39 0x3A 0x3B	Always first read the SpeedHH register!!! These 4 variables contain a copy of the 32bit Speed
TorqueL TorqueH	0x5A 0x5B	Always first read the TorqueHH register!!! These 2 variables contain a copy of the 16bit Torque
TorqueBiasL TorqueBiasH	0x3C 0x3D	These 2 variables contain the 16bit Bias of the Torque Measurement

KpSpeedL KpSpeedH	0x3E 0x3F	 Kp for speed PID
KdSpeedL KdSpeedH	0x40 0x41	 Kd for speed PID
KiSpeedL KiSpeedH	0x42 0x43	 Ki for speed PID
SampleTimeL SampleTimeH	0x44 0x45	Sampling time [h=SamplingTime*1.6us] (20MHz)
BlockedTime	0x46	Time to wait before the motor is considered blocked [T=BlockedTime*256*h]
IntGenPeriod	0x47	Period of internal function generator [T=IntGenPeriod*256*h] (0..255)
IntGenAmplitude	0x48	Amplitude of internal function generator (0..255)
IntGenOffset	0x49	Offset of internal function generator (-127..127)
SoftStopMin	0x4A	32bit Position of SoftStop minimum
SoftStopMax	0x4E	32bit Position of SoftStop maximum
Acceleration	0x52	Acceleration for trapezoidal speed profile (0..255)
StaticFriction	0x54	Friction of the system (0..255)
SWCurrentLimitL	0x56	Software current limit (16 bit)
SWCurrentLimitH	0x57	used for blocked detection and software current limit
MinSampleTimeL MinSampleTimeH	0x58 0x59	 Time used to pass one cycle
TorqueL TorqueH	0x5A 0x5B	Always first read the TorqueHH register!!! These 2 variables contain a copy of the 16bit Torque
MinSpeedL MinSpeedH	0x5E 0x5F	 Minimal consigne Speed for regulation control with trapezoidal or constant speed
NearTargetMargin	0x60	Margin for near target flag setting and speed profile
KpPos	0x61	Kp for Position PID
KdPos	0x63	Kd for Position PID
KiPos	0x65	Ki for Position PID
KpTorque	0x67	Kp for Current PID
KdTorque	0x69	Kd for Current PID
KiTorque	0x6B	Ki for Current PID
MaxSpeed	0x6D	Maximum speed for trapezoidal speed profile

B Serial Commands Summary

A Set Position

Command:	A, mot, position.32
Answer:	a
Effect:	Set the position counter for the given controller.

B Read Software Version

Command:	B
Answer:	b, TranslatorVersion, ControllerVersion
Effect:	Give the software version for the translator firmware and the motor controller firmware.

C Configure PID controller

Command:	C, mot, RegulationType, Kp.16, Kd.16, Ki.16
Answer:	c
Effect:	Configure the PID controller for the given regulation, set the proportional (Kp), integral (Ki), and derivative (Kd) gain. These parameters must be set separately for each regulation type.

D Unused

E Get controller status

Command:	E, mot
Answer:	e, 0x*StatusFlags*, 0x*ErrorFlags*
Effect:	Return the status and error flags for the given controller. Refer to section 3.2 for flags definition. Both returned values are 8bit integer.

F Unused

G Unused

H Set Source for the Regulation Target Point

Command:	H, mot, RegulationType, Source, Period, Amplitude, Offset
Answer:	h
Effect:	Set a new target point source for the given controller. The default source is to use external commands from the translator. This command will start regulation according to the new source, other relevant parameters should be set fisrt.

I Unused

J Set Speed Profile

Command:	J, mot, MaxSpeed.16, Acceleration
Answer:	j
Effect:	Set the speed profile for regulation type 2, which is position control using a trapezoidal speed profile.

K Unused

L Set System Limits

Command:	L, mot, RegulationType, ValueMin.32, ValueMax.32
Answer:	l
Effect:	Set software limits for position, speed or current. The affected limit is determined from the given regulation type. 1 or 2 affect position, 3 or 4 affect speed, and 5 affects current. **Warning:** to set the current limit, only the 16 least significant bits of the *ValueMin* are used. These 16 bits are interpreted as an unsigned integer.

M Get Measurement

Command:	M, mot, RegulationType
Answer:	m, Measure
Effect:	Get speed, position or current measurement from the given motor. The returned value is a 32bit integer and the measurement is determined from the given regulation type. 1 or 2 give position, 3 or 4 give speed, and 5 give current.

N Search System Mechanical Limits

Command:	N, mot, BlockedTime, Speed.32
Answer:	n,
Effect:	Use the given speed, to initiate limits detection cycle. The limit detection is based on the current limit set with L, and the given time. Refer to section 3.8 for a detailled description of the detection cycle.

O Set Controller Options

Command:	O, mot, HardwareOption, SofwareOption
Answer:	o
Effect:	Set options for the given controller, refer to section 3.3 for a detailled description of available options.

P Set New Target Point

Command:	P, mot, RegulationType, TargetPoint.32
Answer:	p
Effect:	Start the regulation to the new target point. The regulation type determine if the setpoint is a speed, position or current target. All other parameters relevant for regulation should be set first.

Q Unused

R Read I2C Register

Command:	R, mot, Address
Answer:	r, 0x*Data*
Effect:	Read a register from the given controller. The returned value is the 8bit content of the register, and the Address should be a valid 8 bit address either decimal or hexadecimal. Refer to section A for register descriptions.

S Save Controller Configuration

Command:	S, mot
Answer:	s
Effect:	Store all registers value to EEPROM for the given controller. These saved values are not erased when the card is switched off and are automatically restored at startup.

T Unused

U Unused

V Unused

W Write to I2C Register

Command:	W, mot, Address, Data
Answer:	w
Effect:	Write a value to the given register. The address should be a valid 8bit decimal or hexadecimal address and the value a 8 bit integer.

X Unused

Y Unused

Z Unused